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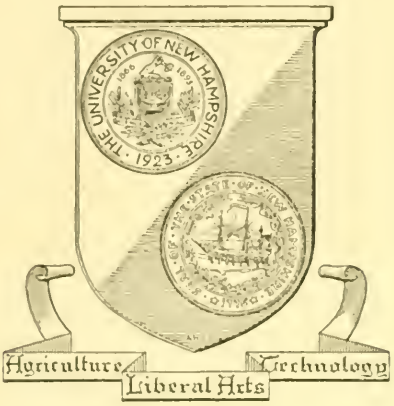

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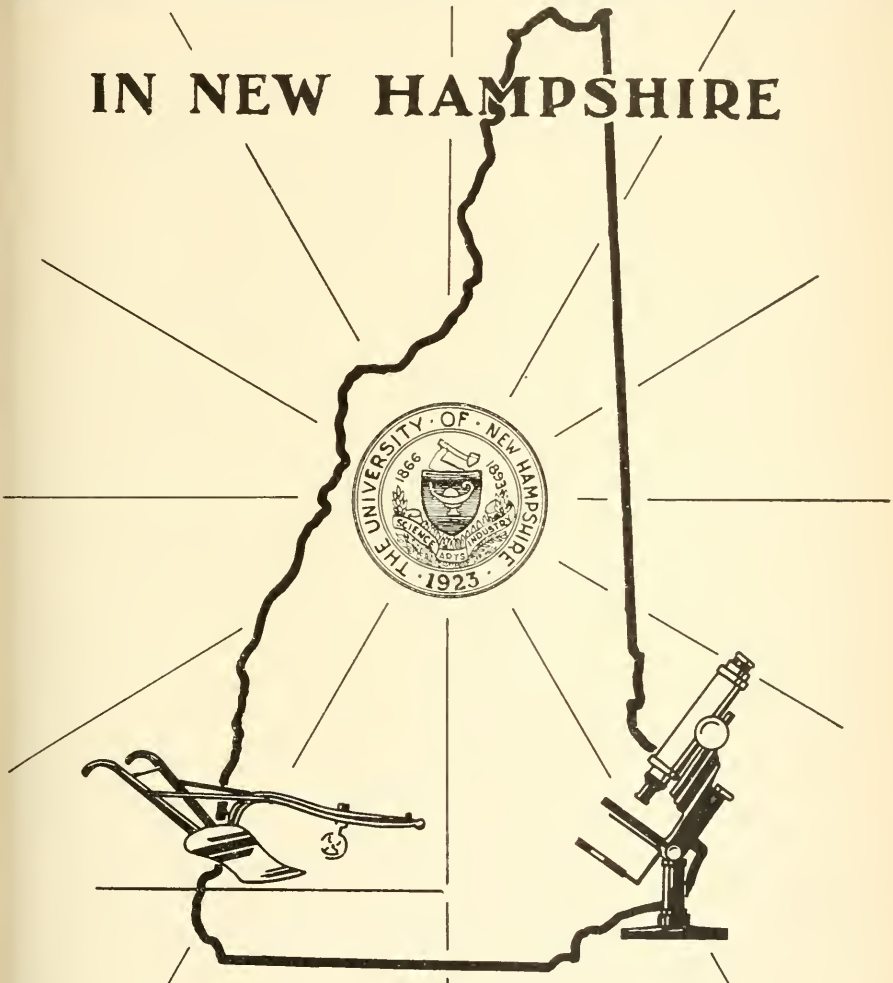
AGRICULTURAL RESEARCH IN NEW HAMPSHIRE



ANNUAL REPORT OF THE DIRECTOR OF NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

FOR THE YEAR 1939

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THE AGRICULTURAL EXPERIMENT STATION
in
NEW HAMPSHIRE

Annual Report of Director M. Gale Eastman for the Year 1939

IN THE LIGHT of the approach of the university's seventy-fifth anniversary, it may be well to preface this year's report with a brief summary of some historical facts that have a bearing on our research activities.

The incentive to state legislative consideration of an agricultural college was the Congressional Land Grant act of 1862, which gave the state 150,000 acres of public land to be used for the support of a college of agriculture and the mechanic arts. This land was later sold for $80,000 and the proceeds invested in bonds. None of this income could be used for building purposes. The state law which established the New Hampshire College of Agriculture and the Mechanic Arts was passed in 1866. It authorized the location of the college at Hanover in connection with Dartmouth.

The college was duly opened in 1868. Its first professor was Ezekiel Webster Dimond, a very able man, who until his death in 1876 worked energetically for the upbuilding of the struggling institution which was frankly considered as an experiment.

Sometime previously, one Hon. David Culver of Lyme had offered his farm and additional cash to a total value of some $50,000 to provide for the location of the new college. Subsequently, this gift went to Dartmouth college because the state did not accept the offer, but through the terms of the donation and Dartmouth's generosity much of this income was used for instructional purposes in the new college.

The building which housed the agricultural classroom work for the remainder of its stay in Hanover was soon forthcoming from the state legislature in a grant of $15,000. Professor Dimond presented such a good case to the legislature that he not only secured the money but the job of designing and constructing the building which came to be called Culver Hall.

Professor Dimond bought a farm himself and donated its use to the instruction of his students. Not long afterwards, John Conant of Jaffrey visited the college and became greatly interested in its agricultural work. He bought Professor Dimond's farm and enough additional land to make a total of 360 acres and presented it to the college. He soon gave $60,000 in securities to establish the Conant scholarships. Later he gave still more money for a building. Conant hall on the present campus now perpetuates his name. It was one of the original four buildings erected in 1893 at Durham. Before leaving, about four more buildings had been erected in Hanover to contribute to an agricultural campus.

One of the buildings at Hanover was the result of additional congressional support. By virtue of the Hatch act of 1887, $3,000 was taken from the newly available federal funds and state monies were added to it to make possible an experiment station building. This began another era in agricultural education.

To be sure, the college moved to Durham in 1893 as a result of the will of Benjamin Thompson, of late a farmer in the new location; and just as surely his gift was a magnificent one, including not only his extensive land holdings but a great deal of money and securities besides. The significant thing, nevertheless, was the new recognition of agriculture as a field for research and the need of such research from an educational point of view.

Up to this time agricultural teaching was uncertain. Facts were few. In our own institution a person educated in history taught courses in agriculture. His training for his task included only a half-hearted early farm experience. There were no textbooks nor "science of agriculture." Twenty-five years later this same man testified facetiously that he had taught agriculture at one time not because he knew anything about it but because he did not know less than any of his contemporaries.

The new era, then, began with the assembling of facts and the search for significant relationships under the title of "agricultural research" initiated by the Hatch act of 1887. Soon textbooks appeared; theories had been proved or disproved; many insects and diseases had been conquered; new plants had been introduced or perfected; improved livestock was the result of more knowledge of breeding—professors had something to teach!

As a matter of fact, the new college had registered ten students at the start, but in 1871 it graduated only three. The late C. H. Hood of Derry was the only graduate in 1880. Whither was this undertaking bound? The lack of interest could not have been due to the entrance requirements: "At present, only the studies in the common school will be required." Nor could the "finals" have been too much of a bugaboo: "The examination at the end of the year will be oral, and in the presence of a committee appointed by the faculty." In other words, the institution was struggling against almost insuperable odds; it lacked the background of knowledge which only scientific experimentation could supply.

Today the University of New Hampshire with a student body scarcely less than 2,000, giving instruction not only in agriculture and the "mechanic arts" but even as far afield as painting, pottery, and social pathology is indeed a far cry from those early beginnings. And who shall say that its triumvirate of services,—teaching, research, and extension,—which now seeks to understand, educate, and help every last family in the state does not result from the devoted efforts of men and women who have given of their best not only in service but through a sympathetic understanding of our rural people and their needs, and an insatiable desire to help them?

In any case, research is the foundation of knowledge and understanding. No man's judgment is better than his knowledge. Research is fundamental to continual improvement in teaching and no

less to extension, which is merely teaching off campus. Research must discover the facts, solve the problems, tabulate the results, and help interpret them so that "he who runs" in his daily acivities "may read."

Agricultural research seeks to help the farmer gain control over the problems that beset him. His is a hazardous business. Few who have not had to live by it realize how hazardous. Only a dyed-in-the wool optimist will presume to expect that all the risks in farming can ever be removed by scientific research, but certainly many can and must be if we are to survive the ravages of civilization. The uncertainties of heat and cold, sunshine and rain must condition the seedtime and the harvest, but more tangible and still less predictable factors may bring disaster. Scarcely a year passes that some new insect or disease does not make its appearance in the country if not in our state. One needs but to look about him to be reminded of the many things that have already been accomplished. Apples are sprayed; potatoes are certified; cattle and poultry are tested for diseases; soils are tested for liming needs; seeds, feeds, fertilizers are checked on their guarantees, etc. Somewhere along the line painstaking, accurate research has made all such practices and services possible.

And the work is still going on. Within this bulletin are to be found references to a great variety of investigations relating to forestry (growth, marketing), botany and bacteriology (spraying, diseases of plants, mastitis), entomology (insect records and controls), agronomy (fertility, rotation, soil surveys), animal husbandry (nutrition, breeding), agricultural engineering (storage, farm machines), poultry husbandry (feeding, brooding, diseases), agricultural chemistry (testing plants, soils, etc.), agricultural economics (land utilization, types of farming, marketing), dairy husbandry (testing milk, feeding calves, analysis of records), horticulture (strawberries, apples, vegetables.) These are problems that have developed on the farmers' own farms. The solution may be found there, quickly or through an elaborate experiment that will take some years; or the problem may be brought, in part or as a whole, to the university laboratories for investigation. Our extension personnel as well as students and others keep the experiment station force in close touch with such problems at their source. It is not possible to do all the work requested. There are always more problems than can be undertaken for want of money, personnel, or facilities. To do painstaking and accurate scientific research in agriculture worthy of public confidence and support requires well-trained men and, in addition, land, livestock, buildings, and intricate laboratory equipment.

Nearly one hundred fifty thousand dollars is spent annually by your director assisted by a staff of some seventy-five people. Only a few of these people work full-time on station problems; their time and remuneration are usually shared with the university in teaching, to the benefit, we believe, of both types of work. Close cooperation is also maintained with the extension personnel and in a few cases time is divided with them. More than two-thirds of the money is a direct grant from the United States government in annual installments, starting with the Hatch act passed in 1887 and coming down

through the Adams (1906), Purnell (1925), and the Bankhead-Jones (1935) acts. Nearly forty thousand dollars comes from service fees, sales of crops and animals used for experimental purposes, and gifts (Carnegie institution). Only about eight thousand dollars is a direct contribution from the state.

This is a lot of money, but in many states the state contribution far exceeds the amounts from Washington. True it is that we cannot do all the research for which we have requests nor even the amount which might easily be justified as worth while and important. An attempt is made to the best of our judgment to select the projects that are most pressing and to search for the solution of problems so that the greatest good may be done to the greatest numbers. We welcome suggestions concerning our research program from the New Hampshire people in whose behalf the station is operated, and to whom our various personnel must often turn for first-hand information and direction.

Last year's report by Director Kendall suggested some of the changes resulting from a readjustment of personnel and housing of departments at this university. The present director's incumbency, beginning as of July 1, 1939, finds all the Agricultural college departments housed with the newly created Biological institute in Nesmith hall, or with the social sciences in Morrill hall, except agricultural chemistry, agricultural engineering, dairy husbandry and the nutrition laboratories and offices of animal husbandry.

Major changes in administration personnel include Alan G. MacLeod, formerly assistant economist in marketing, changed part-time to assistant to the director; Henry B. Stevens, formerly agricultural editor and executive secretary, now in charge of editorial work for station, extension and the university; John W. Spaven, formerly editorial assistant in the extension service, now has part of his duties assigned under the title of assistant editor for the station; Robert True in the business office has become part-time assistant to the treasurer; and Miss Josephine Taub is librarian, part-time station, on duty at the new agricultural library in Nesmith hall.

Department personnel includes as the principal change the appointment of Albert F. Yeager, as head of the horticulture department. The research work in the forestry department formerly done by Karl W. Woodward has been taken over by Clark L. Stevens as head of the department. Paul N. Scripture was relieved of his work in the soil survey to give his full time to agricultural chemistry work, and Walter H. Lyford has relinquished his association with agricultural chemistry to devote full time to the soil conservation work in agronomy. Reeshon Feuer has also given a half-year of assistance in the soil survey.

The new demands for extension work as well as research associated with the Land Use and Unified County programs made some adjustments in agricultural economics personnel desirable. Harry C. Woodworth was relieved of a small share of his station assignment. Byron Peterson was taken on as a graduate student, and John C. Holmes was added to give a small amount of time to land use problems.

In agricultural engineering, a graduate student was added part-time in the person of Benjamin J. French. Kenneth Anderson as a graduate assistant, and Mrs. B. G. Sanborn as a laboratory technician, were added part-time to assist with bacteriology, now organized in the botany department. In poultry, Richard Ford as assistant technician swells the force that handles the ever-increasing pullorum testing. The usual replacements in graduate students have been made.

The absence of the extension agronomist, to do graduate work, has made some reallocation of tasks among the remaining personnel necessary. Similarly, the work of Albert E. Tepper has been suitably absorbed in the poultry department during Mr. Tepper's absence for graduate study.

Publications and Editorial Service

	No. pages	No. copies printed
Station Bulletin 308—Feeding Stuffs Report 1938	92	2500
Station Bulletin 309—Results of Seed Tests 1938	22	2500
Station Bulletin 310—Vitamin "A" Requirements of Growing Chicks	23	4000
Station Bulletin 311—Inspection of Commercial Fertilizers 1938	14	2500
Station Bulletin 312—Protein Requirements of Chickens	20	4000
Station Bulletin 313—Station Report 1938	34	2500
Station Bulletin 314—Agricultural Conservation	32	3000
Station Circular 55—Bovine Mastitis: Cause, Detection and Control	7	5000
Technical Bulletin 71—The Blood of the Cockroach (Contact Insecticides XIII)	23	3000
Technical Bulletin 72—Methods for the Diagnosis and Control of Bovine Mastitis	14	3000
Technical Bulletin 73—Some Effects of Potassium and Nitrogen on the Composition of the Tomato Plant	11	3000
Scientific Contribution 66—An Individual Chick Cage for Use in Poultry Nutrition Studies	3	300
Scientific Contribution 67—Incompatability of Early McIntosh and Cortland Apples	4	300
Scientific Contribution 68—Horizon Variations of Three New Hampshire Podzol Profiles	5	300
Scientific Contribution 69—Phosphorus and Potassium as Supplements to Nitrogen in Sod Mulch Orchards in New Hampshire	4	300
Scientific Contribution 70—Response of Howard 17 Strawberry to Sodium Salts	8	300
Scientific Contribution 71—Experimental Production of Winter Injury to the Trunks of Apple Trees by Applying Nitrogenous Fertilizers in the Autumn	4	300
Scientific Contribution 72—Variations in Cooking Quality of Potatoes as Influenced by Varieties	8	300
Total	328	37100

Agricultural Chemistry

The Effect of Potassium Deficiency on the Metabolism of Plants

This project has been completed and the results have been published in Technical Bulletin 73, entitled "Some Effects of Potassium and Nitrogen on the Composition of the Tomato Plant."

(Adams Fund)

The Chemical Composition of Timothy

A series of samples, simulating grazing, was taken during 1939. These principles have been extracted and are ready for analysis, report T. G. Phillips and T. O. Smith.

A modification of the Bertrand titration method for the determination of reducing sugars has been devised for use with small amounts of sugar. This method is quite promising and is being tested in several laboratories besides our own.

The possibility of determining fructose in the presence of glucose is being studied. *(Adams Fund)*

Inspection of Feeding Stuffs and Fertilizers

In the enforcement of the law regulating the sale of concentrated commercial feeding stuffs, 471 brands were analyzed for the State Department of Agriculture. The analyses required about 3550 individual determinations.

One hundred six brands of commercial fertilizers were also analyzed for the State Department of Agriculture. These analyses required about 790 determinations. *(Miscellaneous Income)*

Lead Residue on Export Apples

At the request of Honorable Andrew L. Felker, commissioner of agriculture, a laboratory was set up to determine the amount of lead remaining as spray residue on apples destined for the export trade. Seventeen samples of apples were run before the European conflict stopped exportation. *(Miscellaneous Income)*

Chemical Services to Residents of the State

Soil Testing. The testing of soils for the residents of the state has been continued. Seventeen hundred fifty-three samples of soil have been received and tested.

Feeding stuffs, fertilizers and other miscellaneous materials to the number of 94 have been analyzed for residents of the state. About 210 individual determinations have been made on these samples. There has been, also, a considerable volume of correspondence relating to inquiries not involving analyses.

Pond and Lake Bottom Samples. In conjunction with Herbert Warfel of the State Fish and Game Department at Concord, work was started on 19 samples of soil taken from the bottom of ponds and lakes. The material was air-dried and the available nutrients were determined. Further work is to be done with these samples, such as determining the organic matter content.

(Miscellaneous Income)

Agricultural Economics

Fruit Farm Studies

The basic data for the study of orchard management problems were revised and rechecked, reports H. C. Woodworth. Cost data in terms of labor hours and materials have been plotted for the commercial life of the orchard. Also the gross income in terms of normal expected yields and money value at different levels has been plotted for the commercial life of the orchard. From these the relative value of trees at different ages has been indicated by discounting future net earnings. The highest potential value of apple trees is reached previous to the period of heavy yields. The young tree with yield sufficient to cover operating expenses has its productive period ahead and has the greatest value.

The manuscript will be completed this spring. *(Purnell Fund)*

The Study of Land Utilization in Grafton County

The pattern of ownership in an area is an important influence in adjustment of local population to local resources. From the data available in the southern Grafton county study, an analysis was made of the size of holdings, residence of owners, and intent of ownership, reports H. C. Woodworth. Of the 1470 tracts of land, only 218 were occupied by owners, but 380 other tracts were owned by local residents living within the same town. Of the remaining tracts, 427 were owned by residents of Grafton county, 150 by residents of the state and 270 by out-of-state people.

Of the 42,438 acres owned by out-of-state residents, only 6,174 acres were associated with summer homes, 29,700 acres were wild land, and 4,101 acres were in vacant farms, and 1,966 acres were associated with operated farms. Approximately 23 per cent of the area was owned by local residents. Thus the management of timber resources on 77 per cent of the total area was held by people who had little concern for the local social and economic problems.

The list of ownership includes 21 states. Massachusetts residents held 122 tracts totaling 18,084 acres and one resident of Arkansas held a tract of 12 acres. For the area as a whole, 924 tracts were under 100 acres, 450 were 100 acres but under 300 acres, and 96 over 300 acres.

John Chandler listed the amount and location of timber logged in Dorchester during the last three years. He did this by interviewing selectmen, land owners, and lumber companies that had logged in Dorchester. We now have a detailed inventory of the forest resources of Dorchester as of 1933 and an annual estimate of the pulpwood and logs taken out. *(Purnell Fund)*

The Conservation Program in New Hampshire

Bulletin No. 314, "The Agricultural Conservation Program in New Hampshire," was published in June, 1939, analyzing the 1937 program in a sample of twelve towns. The 1939 AAA records of participants in the program were examined and data concerning the use of lime and superphosphate were analyzed. These indicated that

about one-half of the superphosphate has been applied to old haylands. According to Ford S. Prince, experiments show rather disappointing results in the applications of superphosphate as a top-dressing on hayland. On the other hand, superphosphate with lime, has resulted in stimulating pasture clover. Probably the superphosphate applied to haylands in 1939 would have resulted in higher returns if it had been applied to pasture land.

In the case of lime, favorable results will probably be experienced wherever the lime is applied. On the other hand, gains from its use may be larger and quicker if applied in preparation for new seeding. Unless the lime on haylands and crops is applied on tillage area which will be plowed and reseeded soon, there is considerable question as to whether this use will bring the highest returns. In order to study the conservation needs in detail, four typical dairy farms were selected in Belknap county. These farms have been mapped and the forest cover has been studied. In addition, the agronomy department has carefully mapped the soil. The next step is to study the tillage, pasture and woodland needs in relation to the soil.

(Purnell Fund)

Type of Farming Areas in New Hampshire

In previous years the land area in five counties, Sullivan, Cheshire, Merrimack, Belknap and Hillsborough, have been classified according to opportunities in commercial dairy farming.

This year Byron Peterson is working on the classification of lands in Strafford county. He has mapped five towns so far and will complete the field work in January. This work includes checking the town inventories for number of cows and hens, checking with local selectmen as to location, and checking with the Agricultural Conservation program records for amount of tillage land. *(Purnell Fund)*

Rural Tax Studies

Field work has been completed in this study which has as its objective to observe the extent of variation in administrative practices in rural towns and to analyze town expenditures in terms of causal factors and account for differences in local tax rates. Income and expenditures are enumerated for the year ending January 31, 1938 (school expenditures for the year ending June 30, 1938), and are now virtually ready for tabulation and summarization. The material will probably be presented in a series of bulletins. The work is in charge of H. C. Grinnell. *(Purnell Fund)*

Pasture Management Study

At the close of the second season on the pasture clearing plots, a more accurate measure of brush control can be determined, reports M. F. Abell. Burning, pulling or cutting are equally effective as a means of controlling juniper, although burning has the advantage of destroying seed. It leaves disagreeable dead brush. Pulling leaves bare spots and necessitates some reseeding. Cutting requires the most labor on juniper. Burning birch is most effective. By continued pasturing the new birch shoots are browsed off and almost complete control is obtained. Cutting birch induces excessive sprouting

and needs heavy grazing to control regrowth. Sweet fern is most difficult to control. The bark is so thick that burning is very slow. The roots break off and new plants start at the joints when pulled. Several new sprouts start when the plants are cut off. Cattle do not browse on the new shoots so there is little control through pasturing. Hardhack is readily controlled by each of the three methods. Pulling early in the spring gives satisfactory results but requires a great deal of labor.

Labor required per acre by the three methods is as follows: Pulling, 100.9 hours; cutting, 68.2 hours; burning, 57.4 hours. On two farms with a heavy stand of sweet fern (*Myrica asplenifolia*) mixed with some hardhack (*Spiraea tomentosa*) and meadow sweet (*Spiraea latifolia*) pulling required 57.7 hours per acre, cutting required 56.6 hours per acre, and burning 42.5 hours per acre. Under these circumstances with better control of brush and no standing brush left to bother, pulling seems to offer best opportunity for control.

On three farms with a heavy almost pure stand of hardhack (*S. tomentosa*) it took 70.8 hours to pull, 51.5 hours to cut, and 14.3 hours to burn. The number of new shoots that start does not vary much on the three plots, but cutting has the disadvantage that the stubs are left to check grazing around the old plants and burning leaves the old stalks to prevent close grazing. Usually one season is long enough to decay them and they break off easily.

On three farms with a mixed stand of brush consisting of juniper (*J. communis*), hardhack (*S. tomentosa*), meadow sweet (*S. latifolia*), blueberry (*V. pennsylvanicum* and *V. vacillans*, low bush, and *V. corymbosum* and *V. atrococcum*, high bush) and sweet fern (*M. asplenifolia*) and little or no gray birch, pulling was very difficult and required the most labor of any class of clearing. Pulling took 159 hours, cutting 54.7 hours and burning 50 hours per acre.

On four farms the stand of gray birch was too large to warrant pulling. This was cut on all plots, pulling and burning only the smaller brush. The labor involved on the various plots was not greatly different, since all plots were treated somewhat alike. On the so-called pulled plot clearing took 315 hours, on the cut plot 277 hours and on the burned plot 196 hours.

This amount of labor does indicate that in order to warrant clearing of large brush the pasture need must be great and the soil such as will provide good pasturage.

Ferns and brakes can be controlled by twice-a-year cutting, June and August. The season was too dry in 1939 to permit any burning. Two farms of the 18 have low bush blueberries, which are a problem, and another year spring and fall burning will be tried on these farms to determine the possibility of killing blueberries in this manner.

Simply cutting brush will not necessarily improve pasture. Much of the result would be simply a change in the kind of herbage or substituting one kind for another frequently worse. To raise the level of fertility to a point somewhat above that required by much of the brush encountered on pastures, lime and fertilizer were added in fixed amounts. In addition to raising the level of fertility to induce the spread of good pasture plants, the effect of different fer-

tilizer treatments on suppressing brush once it had been checked by cutting was studied. Fertilizing also increased the amount of grazing on the plots and, consequently, the browsing on new brush shoots.

There has been some greater response to lime on those plots where the pH was below 5.00 but this has not been uniform. On the 12 farms with a pH on untreated soil of 5.06 the response has been greater with more grass and clover coming in than on 5 farms with a pH of 4.88. Lime and superphosphate have had a suppressing effect on ferns (*P. aquilina, D. punctilobula, P. acrostichoides*) and bluets. Lime has also reduced the vigor of blueberries.

With a low pH at the start, 4.79, and an increase to 5.18, on 8 plots response in greater amounts of clover and good grasses and less brush regrowth was good only on 5 plots; while with a relatively high pH at the start, 5.20, and an increase to 5.36 on 9 farms response was poor on only 1 farm. It would appear that in order to get good response from superphosphate and complete fertilizers a pH of 5.0 or higher is desirable and then response is not only due to fertilizers but to lime. The nitrate of soda plots showed a stimulating effect on brush and ferns and poor grasses with no tendency to bring in clover. On one plot nitrate of soda did reduce the amount of moss. The superphosphate and potash plots were generally poorer than the lime and superphosphate or lime and complete fertilizer, and were usually as good as the complete fertilizer alone. *(Purnell Fund)*

Efficiency Studies in Dairy Farming in New Hampshire

A bulletin summarizing this study is in preparation and will be published early in 1940. *(Purnell Fund)*

The Marketing of Small Fruits

Field work has been completed and a publication will be issued shortly. The objective of this study has been to bring together facts concerning production, varieties, methods of sale, and prices obtained, in order to learn what opportunities exist in production and sale of small fruits, how local markets may be more fully utilized, and what may be done with surpluses should they arise. Blueberries are the only small fruit produced in surplus quantities, and these are wild varieties. Other small fruits usually sell at premiums in local markets, and at prices above those of most other states.

(Purnell Fund)

Economies in the Purchases Made by Farmers

This study in economies in the purchases made by farmers, in charge of L. A. Dougherty, has been undertaken in order to learn more concerning:

(a) Practices used by farmers in making purchases of production and some types of consumer goods;

(b) What economies are available—and utilized—as may be involved in:

(1) Cash vs. credit purchases.
(2) Large vs. small purchases.
(3) Own transportation vs. delivery.
(4) Bulk vs. package goods.
(5) Advance orders.

(c) Adjustments that might be made which would facilitate greater economies in purchasing.

Farmers, dealers, and retailers are being visited in several areas in the state and to date contacts have been made with approximately 280 farmers, 60 retail stores, and 10 farm supply dealers in the following areas:

(a) Keene
(b) Claremont-Newport
(c) Milford-Wilton
(d) Rochester-Dover
(e) Manchester
(f) Wolfeboro
(g) Colebrook
(h) Grafton-Wentworth

The data collected have not yet been summarized, but some observations have been made as follows:

(a) Farmers can add materially to their net profits for the year by giving more study to purchasing of supplies.

(b) These savings which can be made in purchasing supplies need not necessarily come through reduction of the profits of individual dealers but can be accomplished through cooperation with dealers in carrying out the most economical practices in distribution and in sharing the savings made.

(c) Numerous cases are found where producers are obtaining or believe they are obtaining special prices and secret discounts. Under such a pricing system, however, the farmer is often not in a position to compare his price with that paid by others.

(d) Gasoline is one commodity which is subject to much price cutting. Some farmers are buying gasoline delivered at their farms for from 1 to 4 cents under pump prices.

Local residents in some sections are buying gasoline below the prices paid by summer people.

(e) Fertilizer price schedules with differentials for services involved are maintained more rigidly than in the case of many farm supplies. Farmers can pay for the service of credit and delivery or not, as they choose.

(f) Farm supply dealers are rather consistently using commercial credit ratings on those customers who take credit.

(g) One of the most important changes that farmers' cooperatives can make in distribution practices is the separate pricing of commodities and services and the rigid maintenance of such differentials. An educational campaign in this connection would be of great service to farmers.

(h) Farmers have access to little unbiased accurate information concerning the comparative values of different brands of feed, other than the analyses reported by various agricultural experiment stations. Competitive feed tests under official supervision might make information available which would be of value to both producers and feed concerns. It would give an opportunity to feed companies to substantiate their claims officially and give producers greater confidence in them.

(i) Competition has often resulted in adoption of practices in distribution which confuse and mislead consumers instead of helping them in making purchases. The increased use of odd weights on packages is an example. Either the use of even weights or pricing in terms of pounds would aid consumers materially. Cooperatives can lead the way and force the issue by giving wider publicity to the subject. One farmers' cooperative is now selling flour in even weights, as 5, 10, 25, 50, and 100 pounds.

(j) Increased attention to buying under specifications or grade, with reduction in the number of brands, should lead to economies in purchasing. *(Purnell Fund)*

The Supply and Distribution of New Hampshire Milk

The field work has been completed and analysis is under way on the second phase of the trucking study. It is expected that progress will be such that publication can be made on this study early in the coming year. A reorganization scheme for transportation routes in the central part of New Hampshire has been completed. Producers shipping at wholesale have been located and, in the case of several of the markets, more efficient trucking systems have been devised.

A good part of the field work on the fourth phase of the New Hampshire study of the supply and distribution of milk has been completed. This phase includes the study of price interrelationships on the supply side of certain New Hampshire markets, reports Alan MacLeod. Prices for areas in New Hampshire where milksheds overlap and two or more markets compete for milk have been secured. In these areas of market competition it is proposed to investigate the adjustments to various price differentials between the markets concerned. Individual farmers' reactions to price differentials are being obtained and the factors retarding adjustment to changed price differentials will be investigated. With widespread price fixing it is becoming more and more desirable to have some measure of the length of the period required to transfer producers from one market to another. This phase of the study should be completed in 1940. *(Bankhead-Jones Fund)*

Marketing Forest Products from Farm Woodlands in Certain Areas of New Hampshire

This study has been completed and publication is now under way, report Alan MacLeod and John Chandler. Farm woodlands supply an important part of farm income in Carroll county, New Hamp-

shire. Woodland acreage in the area studied totals 223,000, of which approximately 52,000 acres supported merchantable timber.

Total stand of merchantable timber approximated 260 million board feet. For the next few years, the annual cut on a sustained yield basis will be about 5 million board feet.

Present market outlets take about 6 million board feet annually. Some 3.5 million of this goes to more or less permanent industries, and the remainder is handled by portable mills. Plant capacities bear little relation to the amount of timber cut by particular industries. In general, effective plant capacities are far in excess of annual consumption.

Comparing the average annual cut in recent years with that estimated to be allowable on a sustained yield basis, it was found that, except for hardwood, the present cut exceeds the increment of merchantable timber.

Stumpage prices have ranged all the way from $1.50 per thousand for low grade or relatively inaccessible hardwood to $5.00 and over for especially desirable pine and spruce.

Log prices have fluctuated considerably over the past fifteen years. Starting at $18 a thousand in 1924 they reached a peak of $20 in 1927 and then declined, first gradually, then rapidly until 1932. From this point to the present except for a slight rise in 1937 they have remained at $10.

Transportation charges have ranged upward from $1 a thousand minimum and tend to vary with distance rather than value of product.

It appears that during the intermediate time period considered the area is well supplied with wood-using industries. These industries have ample capacity to take care of a normal production.

Farm income from the sale of woodland products was about $30,000 in 1929. This income could be increased by making more efficient the assembling and sale of forest products, increasing the labor income by the owner himself doing more of the logging and assembling operations and adopting improved production practices.

Cooperation offers opportunities for increased farm income from marketing forest products in the area. A large proportion of the woodland containing merchantable timber was found to be in the hands of persons favorable to cooperative effort. Another fair-sized portion was controlled by those indifferent, and only a small amount was in the hands of persons definitely antagonistic to cooperation in this field. Directions in which cooperative effort might be most successful are: assembling sawlogs, keeping in touch with markets and market conditions, bargaining as a unit for members, and perhaps assistance to members in forest management. As the annual business of a cooperative which confines its activities to marketing forest products would be in the neighborhood of $40,000, operating expenses should be less than $4,000, an amount probably insufficient to maintain an organization and a manager on a full-time basis. There are already ample processing facilities located in the area.

(Bankhead-Jones Fund)

Agronomy

Legumes on Neglected Haylands

This is the first year the Whenal alfalfa plot at Greenland has been harvested under the present fertilizing scheme in which annual fertilization is being compared with three times the annual amount applied just before the time of seeding. Units consist of 300 lbs. 20% superphosphate and 100 lbs. 60% muriate of potash.

The weather during the growing season was very dry all over New Hampshire, especially after the first alfalfa harvest, and because of this only one harvest was taken. While it would be unwise as yet to draw any conclusions, two things do stand out. One is that potash causes greater stimulation to alfalfa than an equal amount of phosphoric acid. This is in line with data previously obtained. The other significant point is that thus far heavy initial applications of both materials have caused higher yields than those in which the amount of one or both materials was reduced to the amount used in the annual application. Apparently the need of alfalfa for both phosphoric acid and potash is greater than that which is supplied by the annual application in the amount used.

Alfalfa plots on the Ireland farm in Greenland were harvested once in 1939 after having been top-dressed in the spring in accordance with the plan of the experiment. Because much grass has crept into the alfalfa stand on this field, it is quite possible that the effects of nitrogen are exaggerated and the stimulation from phosphoric acid and potash is somewhat minimized. The experiment would appear to indicate, if costs are considered, that the maximum top-dressing that can be used with any profit will approximate 300 pounds of 10-20-20 and 300 pounds of 0-20-20 fertilizer per acre annually.

The effect of different rates of liming has also been studied. Plots were sampled as usual in the fall of 1938 at two-inch levels down to eight inches and analyses made for pH values.

Oats were grown as a nurse crop this summer and were sampled for analytical work. Because of the dry summer, the seeding of clover failed and was replanted in September. This will be sampled next summer. The phosphorus content of the first cutting of alfalfa in 1935 showed an increase with increasing rates of liming, being 0.539 per cent for no lime and 0.777 per cent for the 8 ton application on the moisture-free basis.

The results on the soy-beans on an air-dry basis showed that both proteins and CaO content increased with larger applications of lime. Protein increased from 12.52 to 16.43 per cent and the CaO from 1.33 per cent to 2.66 per cent.

Potatoes in a Three-Year Rotation

The experiment at the Jackson farm in Colebrook has concerned itself with a three-year rotation of potatoes, oats and hay in which all the fertilizer is applied to the potato crop. The oats and hay merely get any excess plant food not used by the potatoes. The second crop of hay is always turned under for the potatoes that are to follow. Data over a period of six years show that phosphoric

acid increases yields of potatoes over and above the amount found in a 4-8-7 fertilizer. They also demonstrate that extra potash added to phosphorus causes a still further increase, but increased potash alone on this soil is not effective.

Lime seems to have very little influence upon potato yields, but very much upon the oats and even more upon the hay yields that follow. On the contrary, acid-forming fertilizers not only depress hay yields, but yields of potatoes as well.

The use of magnesium in the fertilizer has not given an increase in potato yield. Likewise, boron used on certain plots at the rate of 20 pounds per acre has not increased yield.

Yields of hay on the Jackson farm were not influenced particularly by residual fertilizer application. They have, however, been distinctly benefited by lime or lime-bearing fertilizer. The data indicate the extreme sensitiveness of hay crops to lime applications.

This study will be reported in detail in bulletin form early in 1940.

(Purnell Fund)

A Fertilizer Experiment with Dairy Farm Crops in the Connecticut Valley

Although a variety of crops has been grown on these plots on the Livingston farm in Claremont, the treatments have not varied since the experiment was set up in 1929. With this background of continuous treatment, deficiencies have shown up where one or more elements were omitted. While in 1938 there was a fairly uniform stand of clover on all plots, by the spring of 1939 the clover had persisted only on plots which had received potash during past years, while on all other plots, no matter what treatment they had received, no clover lived over. In addition to the fair proportion of clover on potash-treated plots, the total yield of hay was increased.

Considering the yields of cured hay per acre in the first cutting for 1939, residual lime effects appeared to have been very slight, although lime applied to plots receiving other minerals slightly increased hay yield. The most striking results are those for potash application. All treatments where potash appeared yielded over two tons of hay per acre. Phosphorus alone does not appear to have much, if any, effect in improving hay yield, although used with potash it promotes a much larger yield of hay than can be accounted for by potash alone. Apparently what is needed on this soil is a balanced fertilizer application. Potash is the element most likely to be limiting to legumes and other hay crops, but for highest yields phosphoric acid should be added to potash. Likewise, farmers who are depending upon lime and superphosphate with manure that has been indifferently cared for or with no manure at all are not realizing their full roughage production possibilities. The fact that clover has persisted in the plots receiving potash is a factor that no farmer can afford to overlook. *(Purnell Fund)*

Top-Dressing Old Pasture Lands

The test of fertilizers on old pastures on the Seavey farm in Stratham was continued through 1938 without change, but was modified

somewhat in 1939. As data for 1939 are not yet available, a seven-year average for the yields of various plots up to and including the 1938 season is considered.

One of the disturbing factors in this experiment is that fertilized portions of the pasture are always grazed more heavily than unfertilized portions. The plots are laid out side by side in the corner of a large field with the check plots scattered among the treated plots. The cows come into this area and feed heavily as the grass is better there than anywhere else, manuring all the plots indiscriminately, of course. Hence, it is likely that the check plot yields come nearer the yields of other plots than would be the case were the plots fenced and grazing controlled on each treatment.

The response for complete fertilizers when compared with equal amounts of nitrogen in the nitrogen-alone plots is distinctly disappointing and differs materially from the results obtained on the Livingston farm.

On the Livingston farm in Claremont the experiment was modified somewhat in the spring of 1938. The soil of these plots is much more sensitive to a lack of minerals than the Seavey pasture. Maximum yields are not secured with nitrogen alone, and the complete fertilizer plots yield more dry matter and proteins than those treated with either phosphoric acid and potash or nitrogen. On the plots which had been treated for five years with only nitrogen, clover appeared almost at once with the application of phosphoric acid and potash. The entire vegetation, pasture palatability and length of season of pasturing were all favorably changed, so starved was the soil for phosphoric acid and potash. The principal difference between the plots treated with phosphoric acid and potash and those on which nitrogen only was applied was in the amount of wild white clover which appeared abundantly in the plots that were generously supplied with complete fertilizers or with phosphoric acid and potash. *(Purnell Fund)*

A Dairy Farm Rotation in Southern New Hampshire with Sweet Corn as Cash Crop

This experiment on the Lane farm in Pittsfield was revised during the past year to include sweet corn in the rotation instead of potatoes. The field is the same as that on which a three-year rotation of potatoes, oats and clover has been grown during the past six years.

Because of serious erosion, the field was divided into strips and cropped on the contour. Nine such strips were laid out crossing previous treatments.

Because the 1939 season was so dry that yields of corn were severely cut, it is very doubtful if the data are of much value. No results, therefore, are being presented except the fact that only a slight increase was obtained for nitrate of potash used as a top-dressing. *(Purnell Fund)*

Soil Survey of New Hampshire

The survey of Hillsborough county, begun in the autumn of 1937, was continued through the 1939 field season. It seems likely that

the survey of this county will be completed early in 1940.

The survey of Strafford county was continued during 1939 with the cooperation of the Soil Conservation service in addition to that of the Division of Soil Survey. The mapping in Strafford county includes an estimate of erosion control and an analysis of land cover in addition to soil types and slope classes. The extra detail has necessitated plane-tabling the open land and has involved much additional time over that required for a survey such as the one in Hillsborough county. The Strafford survey will probably be finished about August 1, 1940. *(Purnell Fund)*

The Determination of Run-Off and Erosion from New Hampshire Upland Soils

In cooperation with Soil Conservation service a detailed map was made of a three-mile section of the Merrimack river below Nashua from which it was possible to evaluate the benefits of different species of riverbank vegetation and to measure the amount and kind of stream bank cutting there. It was found that stream bank cutting contributed practically all the sand which washed on valuable farm land during floods. With a view to control stream bank erosion, studies were conducted in the greenhouse on the rooting of cuttings from several species of plants found on river banks. Chemicals which induce rooting were tried on these cuttings. Willows and spirea species were found to be most promising for stabilization of river banks. The chemicals aided rooting in some instances but did not influence the subsequent rate of growth of the rooted cutting.

Four banks on the Merrimack river were selected in June, 1938, for a study of the rate at which the unprotected sand was washed away by the river. Cross sections of these banks were obtained at that time. A year later, a second survey of the same banks was made and the amount which had washed away during the year was calculated. The banks which were on the outside of the bends and subject to direct and constant action of the water exhibited the most cutting.

The river bank project was discontinued in July, 1939, and attention directed to the losses occasioned by erosion on upland potato farms.

During the summer an exploratory survey of the state has been made. The soil types upon which potatoes are grown, and the amount of erosion that has occurred on these soils have been recorded. Most of the potatoes are grown upon the heavier soils. The rolling upland soils upon which potatoes are grown are predominantly loams and silt loams and have a hardpan at about 20 inches. This hardpan insures an adequate water supply for crop growth by preventing rapid gravitational flow of water, and this very characteristic also contributes to sheet erosion. Paxton loam is the typical upland potato soil in southeastern New Hampshire, and studies will be confined to this soil.

A field has been selected at Northwood Ridge for the establishment of run-off plots to ascertain the time of year erosion takes place and the conditions which cause it. One plot is entirely grass,

another is fall plowed, while the third is fall plowed and harrowed. Another plot has been established temporarily on the experimental plots at the Lane farm in Pittsfield. The comparison of these two soil conditions will provide data on the infiltration rate, the effect of frost, the value of different kinds of cultural practices, the time of year when erosion takes place, and the amount of soil removal.
(Purnell Fund)

Pasture Species under New Hampshire Conditions

During the spring of 1939 about 2500 individual plants were grown in flats in the greenhouse and later transplanted to a nursery on the university farm. These plants represent 15 species and strains, although the major portion of them consist of but 3 species, timothy, red clover, and wild white clover. The first objective is to isolate certain promising native strains of these three species.

In addition to these individual plant propagations, about 60 small plots were seeded to some of the "improved" grasses and clovers that have been developed in other parts of the world. Strains from Wales, Scotland, Sweden and Canada, as well as from various points in the United States were used.

Plots which had been seeded in 1936 to mixtures containing Ladino carried 26 per cent of this clover at the end of the three-year test. Plots within this group that had smooth brome or orchard grass as components of the mixture carried considerably more Ladino than those in which reed canary grass had been used.

Kentucky bluegrass, although seeded in but four of the 64 plots, appeared in all plots except four at the end of the period, averaging slightly over 30 per cent of the stand in those plots in which it appeared. This suggests that the ultimate pasture on this soil and in this climate and under close clipping or grazing will be composed largely of Kentucky bluegrass with such Dutch or wild white clovers as are able to compete with it.

With respect to the strains used, neither timothy nor brome grass will survive for any considerable length of time under close grazing or clipping, at least until strains better adapted to pasturing or for the climate are secured.

Tests were made by the department of agricultural chemistry on the protein content of various grasses. In the majority of the grasses, the protein content was fairly high. However, the grasses were row-grown, cultivated, and well watered. *(Bankhead-Jones Fund)*

Variations in Cooking Quality of Potatoes

Two articles have been published on the influence of variety and fertilizer treatment on the cooking quality of potatoes. In addition to these, it is proposed to publish a résumé of this work together with similar tests on the 1939 crop in a bulletin dealing with potatoes.

The method used to determine potato quality is based on the promise that potatoes with a high specific gravity are mealy and presumably higher in starch content than those with a lower specific gravity. *(Purnell Fund)*

Seed Inspection

The regular seed inspection work for the State Department of Agriculture was conducted as usual. During the year 482 samples of seed were handled in the laboratory. Of this number 426 were collected by the State Inspector and are reported in Bulletin 316; the remaining 56 samples were sent in by private individuals. The referee work was done as usual.

The work was done by Mrs. Bessie G. Sanborn, seed analyst, assisted by students. *(Miscellaneous Income)*

The agronomic projects reported above have been in charge of Ford S. Prince, assisted by Paul T. Blood and L. J. Higgins. Chemical soil studies have been conducted by T. G. Phillips, G. P. Percival and P. N. Scripture. Soil surveys were made by C. S. Simmons, Division of Soil Survey, United States Department of Agriculture; Reeshon Feuer, New Hampshire Agricultural Experiment Station in Hillsborough county; and A. E. Shearin, Division of Soil Survey, United States Department of Agriculture; F. J. Gladwin, Soil Conservation Service, United States Department of Agriculture, and W. H. Coates, New Hampshire Agricultural Experiment Station, in Strafford county. Erosion studies were in charge of W. H. Lyford, Jr.

Animal Husbandry

A Study of the Metabolism of Dairy Cattle During Growth

This study, first reported on last year, has been continued by E. G. Ritzman to the point where cattle are due to drop their first calves.

At about eight months of age when the experiments were first begun, the basal metabolism was very high, average 13,300 calories per 500 kgs. weight; but some twelve months later this had dropped twenty-five per cent. From this period to date, various stages of pregnancy indicate that up to four or five months this condition does not materially affect the basal metabolism, but that a month before parturition (8 to 8½ months pregnant) the basal metabolism is about 30 per cent higher than in the non-pregnant heifer. The extent to which these values may be affected by seasonal variations in metabolism due to other factors is as yet not clear.

A beginning has been made this year to determine the basic cause of these seasonal variations in basal metabolism by a study of the influence of light. This study has been begun with the consultant cooperation of Dr. John W. M. Bunker, physiologist of the Massachusetts Institute of Technology, and Dr. Milton O. Lee, endocrinologist of the Harvard Medical School.

Eight heifers were used in this study, four being subjected to accessory illumination and four being kept in stalls in which most of the light was through heavily shaded windows. The illumination around the dark stalls was so low that with a reasonably sensitive illuminometer no readings could be recorded.

Delays in securing equipment prevented the start of the experiment until the middle of January when the animals had already been subjected to the normal shortage of natural daylight for about three

months. After seventy days, the basal metabolism of the darkened cows remained essentially the same (increase 2 per cent), whereas the animals with extra light showed an increase of about 10 per cent in basal heat production. While the data so far suggest an increase in metabolism as an effect of longer exposure to light, the results can be regarded as only tentative, and it seems advisable that a series be carried out in which the extra lighting is applied as early as October.

A number of gas check tests have been carried out with the mask and apparatus designed to measure the energy expended by the horse during work. The check tests with carbon dioxide gas show a recovery of 99.2 per cent. Twelve actual experiments in which this mask and apparatus were used on a draft type horse (gelding) weighing 650 kgs. have so far been carried out. First trials were made with the horse quietly standing, and these were checked with a metabolism measurement made under similar conditions in the respiration chamber. The results checked closely.

A sequence of trials was carried out on a flat-surfaced road. The results given as calories of energy expended per hour are shown in the following table:

Road work	Calories	Calories	Calories	Calories
Standing	698.3	816.0	———	804.0
Walking	2724.5	2322.0	2717.0	1967.0
Trotting				
5 M. P.	———	3540.0	3841.0	3882.0
10 M. P.	———	———	5565.0	4620.0

This is, so far as we know, the first time on record in which the energy expended by the horse at a gait faster than a walk has been measured. The gratifying feature of these attempts is primarily the fact that this mask and the technique involved have been demonstrated to be dependable, thus opening an entirely untouched phase in the study of energetics.

A series of monthly experiments was carried out during the year on five Chester White pigs to determine the basal metabolism during growth. This work is being continued. *(Purnell and Adams Funds and Carnegie Institute of Washington, D. C.)*

Sheep Breeding

While it is evident as has been previously shown[1] that exceptional fecundity as represented by constant twinning in sheep is a trait of exceptional individuals and of a hereditary character, the effort to develop this trait in the flock as a whole has presented some very perplexing problems which still remain unanswered. One of these is the fact that under apparently identical conditions of feeding and general management some ewes are very irregular in twin production from year to year.

A beginning was made this past year to determine whether changes in nutritional condition as represented by factors other than suf-

[1]N. H. Technical Bulletin No. 47, 1931.

ficiency of protein and of energy may be the cause of this irregularity.

The whole flock of breeding ewes was drenched with a saturation dose (28 ccs. per ewe) of wheat germ oil two weeks before the 1938 mating which was followed up by a dose of 20 ccs. a few days before mating. After mating was begun they were given 10 ccs. every ten days until the middle of January or about a month before lambing where it was deemed unwise to subject them to the rather active process of drenching. The rams were likewise treated until the matings were over. The method by which this wheat germ oil was given is described by Dr. Martin on page 44.

It seems difficult, from the results, to attribute any specific effect toward an increase in twinning from wheat germ oil. The percentage of lambs from 48 adult and 16 yearling ewes in 1938 was 148 as against 146 per cent from 30 adult and 25 yearling ewes in 1939. Of 25 adult individuals which were bred both in 1938 and 1939, 11 produced twins and 4 produced singles in both years, 4 which dropped twins in 1938 produced singles in 1939, and 6 which produced singles in 1938 dropped twins in 1939. This trend toward decrease in twin production of the flock as a whole was apparently due to the greater proportion of yearling or first lamb ewes in 1939, the controlling factors being fundamentally of a hereditary rather than of a nutritional nature. Certainly this cannot as yet be taken as proof that materializing the inherent fertility in sheep is any less dependent on an adequate supply of any one of the recognized reproductive vitamins which have been shown to be essential for reproduction by the rat.

With our almost entire lack of knowledge regarding the effect of variations in soil and seasonal variations in rainfall, temperature, etc., on the nutritive value of our grazing lands and fodder crops it rather emphasizes the fact that fundamental knowledge of the probable physiological requirements of livestock has outstripped knowledge concerning the character of their food supply. *(Adams Fund)*

Botany

Plant Injuries Caused by Lime Sulphur Sprays

Bean plants sprayed with 1 per cent flotation sulphur outyielded the non-sprayed plants, reports O. R. Butler. The plants sprayed with 2 per cent flotation sulphur yielded less than the non-sprayed plants.

Potatoes grown at a mean temperature of 16° C. and sprayed 4 times with lime-sulphur solution 1-50 showed a reduction of crop yield of 9.78 per cent due to spraying. *(Adams Fund)*

Effect of Soil Moisture and Fertilizer Placement on the Vitality of the Potato Seed Piece

Seed pieces from the distal end of potato tubers were used in clay loam and sandy loam at two mean-growing temperatures, 19.3° C. and 14.3° C. Fertilizer treatments for each were: no fertilizer, fertilizer 28 gms. per plant (1000 lbs. per acre) spread in a circular band

2 inches wide with open space 2 inches in diameter, fertilizer 28 gms. spread ½ inch distant from seed, fertilizer 21 gms. spread ½ inch distant. All plants were grown in galvanized pails at 60 per cent saturation in soil moisture.

Results as reported by Stuart Dunn, are: 1. Rate of emergence from soil shows as before that fertilizer has slight or no inhibiting effect in any treatment in either sandy or clay soil.

2. Rate of growth is greater with fertilizer treatments, except with sandy soil at warm temperature. There some inhibiting effect was found.

3. Relative growth at time first measurements were taken again is less for the fertilizer placed close than the non-fertilizer treatments and varies up or down for the other treatments. Even those at a distance with the 21 gm. amount showed some inhibition in both soils at the cold temperature. This suggests the desirability of testing smaller amounts of fertilizer and also of different amounts of soil moisture.

4. Yield is over twice as great for all fertilizer treatments as for non-fertilizer with clay in the cold house and almost as great in the warm. This agrees with previous results. Yield was considerably smaller with sandy soil than clay at both temperatures and the close treatment showed no increase at all over the non-fertilizer.

A second series of plants was grown later in the season at only one growing temperature. Distal seed was used in sandy loam at a mean-growing temperature of 22.6° C., and at three soil moisture percentages, 50, 60 and 70 per cent of saturation. Fertilizer treatments for each were: no fertilizer, fertilizer 28 gms. spread ½ inch distant from seed, fertilizer 21 gms. spread ½ inch distant, and for the 60 per cent moisture only, 14 gms. spread ½ inch distant.

The results were: 1. As in previous tests the fertilizer treatments do not affect rate of emergence very markedly in any soil moisture percentage.

2. Rate of growth is again greater with fertilized plants than non-fertilized in all soil moisture percentages.

3. Relative growth at time first measurements were taken varied considerably, the least amount of fertilizer showing least growth. Since yield was good for this treatment, there is some doubt as to the reliability of this measurement as an indication of fertilizer effect.

4. Almost none of the yields for fertilized plants was greater than non-fertilized, except in 70 per cent soil moisture. Low fertilizer gave as good yield as higher for the 60 per cent plants.

(Adams Fund)

Spraying for Apple Scab

Flotation sulphur paste at the rate of 16 pounds per 100 gallons was used by O. R. Butler in all applications. Experiments were made for the purpose of studying the value of a third-cover spray, and the value of a supplementary spray between the pink and calyx when the calyx spray is not given within 14 days. The supplementary spray was applied 14 days after the pink application, and the calyx spray 19 days after the pink. The results obtained indicate that the

supplementary spray did not better scab control, and that three cover sprays did not give materially better control than two.

Lime-sulphur solution is very commonly believed to "burn out" scab. However, scab on foliage was not killed by spraying with lime-sulphur as the organism sporulated freely around the edges of the dead infected tissues. *(Hatch Fund)*

Ascospore Discharge Relation to the Apple Scab Spray Schedule

Most standard spray schedules for apple scab base their time of application on different stages of the development of the buds, foliage, and fruit of the host tree. More recently, there has been considerable work done towards timing the application of the sprays by the activities of the fungus. Records for the past eight years of experimental spraying at the New Hampshire station have been kept by S. Dunn with a view to determining something about the effectiveness of such methods and the relation of the development of the fungus to some environmental factors.

There is considerable variation in different seasons in the duration of snow cover. Records were kept of the total number of days that snow covered the ground in the experimental orchard, and subsequently the date on which ascospores were first shot was determined by placing greased slides over scabby leaves on the ground. This was preceded by frequent microscopic examinations of the contents of the developing perithecia to forecast the maturity of the ascospore. It was found that while the time of snow cover varies considerably, the dates of spore shooting varied but slightly from year to year except for 1939 and were not in accordance with the length of snow cover. From this it is concluded that the duration of snow cover has only slight influence on this function. Frequently the fungus will vary considerably from year to year in its rapidity of development, but it will usually finally mature its spores for shooting at close to the same time each year.

In only three of the eight years did the time of initial spore discharge occur later than the regular date of application of the pre-pink spray. Furthermore, in two of these years the spores were shot very soon after, five days later in 1933 and six days later in 1935. This raises the question of economy of time in spraying. For six of these seasons a plot of trees was given applications of the pre-pink spray in accordance with the time spores were first shot. For four years where the dates agreed, the spray on these plots was put on at the regular time. In the other two just mentioned the time of spraying was later but came before the pink spray, so that no time was gained. It was necessary to put on the same number of sprays for these plots as for the others. Only in the year 1939 could the pre-pink spray have been omitted safely on the basis of such information. *(Hatch Fund)*

Seed Certification

Seventy-one acres of Green Mountains were entered for certification and the entire acreage passed. Three acres of Chippewa and 1.5 acres of Irish Cobbler were also entered and passed.

(Miscellaneous Income)

The Effect of Mulching on the Development of Bitter-Pit in Apples

The results of chemical tests for available nutrients in small samples from the mulched and non-mulched trees taken in previous seasons have shown that the soil under the mulch contained considerably more available potassium than did that under the non-mulched trees. In order to see whether the mulched trees were taking up any of this additional potassium, leaf samples were taken at three different dates. The June 7th samples showed no consistent difference but both the July 17th and September 20th samples showed that the petioles of the mulched trees contained more extractable potassium than did those from the non-mulched trees. Samples of soil have been taken from beneath each tree in order to determine how far the soluble organic matter from the decaying mulch has penetrated.

The non-mulched trees last year, however, produced a higher percentage of large apples, reports O. R. Butler. The fruit was very free from bitter-pit, only .03 per cent being found on the apples from the non-mulched trees and .5 on the crop from the mulched trees. In storage, the sample of fruit from mulched trees developed 8.62 per cent and the one from non-mulched trees 3.36 per cent bitter-pit. *(Purnell Fund)*

Effect of Place on Mosaic and Leaf-Roll

Potatoes were grown in one series of experiments at a mean temperature of 19.3° C. and in another series at a mean temperature of 14.3°C. In the series grown at the higher temperature two types of soil were used: 1. a light fertile loam (soil A); 2. a sandy loam from an old pasture (soil B). Finely ground peat was added to each soil and the following fertilizer treatments were given.

Soil A per plant: series 1, no fertilizer; series 2, 21 gms. 8-16-16; series 3, 35 gms. 8-16-16.

Soil B per plant: series 1, 150 gms. dry cow dung and 5 gms. bone meal; series 2, 21 gms. 8-16-16; series 3, 28 gms. 8-16-16; series 4, 35 gms. 8-16-16. Data were taken by O. R. Butler on the rate of growth, and observations were made on the masking of symptoms. In the plants fertilized with cow dung the general appearance of the series grown at 19° and 14° C. respectively was very similar and one had no difficulty in matching plants issued from the same seed piece, even when grown at different temperatures. In the fertilized series the plants grown at the higher temperature showed less marked symptoms of mosaic than those grown at the lower temperature and plants issued from the same seed piece could not be matched with certainty.

The nitrate nitrogen content of the soil was determined after the the plants had grown for 34 days. The soil in the series fertilized with cow dung contained very little nitrate, but in the series receiving chemical manure there were large amounts. High nitrate nitrogen depressed growth and yield. High nitrate nitrogen was more injurious to the plants grown at 19° C. than to those grown at 14° C. Between 40-50 parts per million of nitrate nitrogen produced highest

yields in the cultures grown at 19° C. but 80-100 parts per million gave the highest yields in the cultures grown at 14° C.

(Purnell Fund)

The Effect of Position in the Bin and Temperature Differentials on Loss of Weight of Potatoes in Storage

Three types of bins of the same cubical content were used by O. R. Butler and P. T. Blood and the air intakes and ventilation flues were similar in size in all three bins. The bins differed only in the manner in which the air intake was distributed. In one bin (bin C) the air intake opened onto the floor of the bin; in another bin (bin B) it opened into a conduit with slatted cover that ran down the middle of the bin for its entire length; and in the third type (bin A) the air intake opened below a false floor of slatted boards. Temperature records were taken at both the top and bottom of the bins; and air movement through the ventilation flues was taken from time to time.

Air movement out of all three types of bins was found to be approximately the same, and controllable within rather wide limits by opening and closing the air intakes or placing more or less hay in the ventilation funnels.

The following data on loss of weight was obtained.

	Length of storage period			Mean temp. entire storage period	
Type of bin	56 days	120 days	186 days	Top of bin	Bottom of bin
	Per cent	Per cent	Per cent	°F.	°F.
Bin A	1.56	2.22	2.53	43.92	41.65
Bin B	1.81	2.77	3.51	42.97	41.57
Bin C	2.26	3.46	3.86	42.98	42.71

(Purnell Fund)

Studies on Bovine Mastitis

Studies on streptococcal mastitis were continued by L. W. Slanetz with special emphasis on the effectiveness of segregation for the control of this disease. From these investigations, it is evident that the detection, segregation and replacement of infected animals is the best method for the prevention and eradication of streptococcal mastitis. However, the utmost care in herd management and sanitation is necessary to control its spread completely when infected cows are kept in the same barn as the mastitis-free animals. Once a herd free from the infectious type of streptococcal mastitis is established, it has been found possible to maintain it in this state as long as no infected cows are brought into the herd.

Considerable attention was given to the classification and significance of staphylococci associated with staphylococcal mastitis. The characteristics of 205 strains isolated from cows in the test herds and 19 strains from human sources were studied. One hundred

forty-eight of the bovine cultures were isolated from the milk of cows infected with staphylococcal mastitis and 57 from the milk of apparently healthy animals.

The coagulase test and hemolysis of blood agar and blood broth proved to be the most consistent and reliable reactions for the differentiation of bovine staphylococci, and the cultures studied could be classified into three groups (I, II and III) on the basis of these tests. Considerable information regarding the pathogenicity of these organisms could also be obtained from these reactions. Sheep's plasma was as satisfactory as human plasma for the coagulase test. All coagulase-positive cultures hemolyzed blood broth and none of the coagulase-negative organisms produced hemolysis in this medium. All toxin-producing strains tested formed either alpha and beta or only beta toxin. Evidence of enterotoxin production by bovine staphylococci was obtained. One hundred and twenty-seven of the 146 Group I cultures (87 per cent), 22 of the 34 Group II strains (64 per cent), and 8 of the 25 Group III cultures (35 per cent) were from cows showing evidence of mastitis infection.

The cultures of staphylococci from human sources gave similar reactions to the bovine staphylococci in all tests employed except in the production of toxin. Ten of the 19 human strains formed only alpha toxin, whereas all of the toxin-producing bovine cultures produced some beta toxin.

The incidence of staphylococcal mastitis was as high as 45 per cent in certain herds and it appears that the Group I staphylococci are the most pathogenic. Studies on the use of vaccines, toxins and bacteriophage for the treatment of this infection are in progress.

(Purnell Fund)

Dairy

Variability in Milk Solids-Not-Fat

During the past year attention was concentrated on the study of two specific factors in relation to the problem; namely, the effect of a change of feed on one of the herds and the study of heredity, reports H. C. Moore.

Four-year data on the solids-not-fat content of milk from individual cows in about 50 herds scattered over the state and from the 15-day composite samples kept by a local dairy company indicate: (1) that cows of the higher testing breeds produce milk higher in solids-not-fat than those of the lower testing breeds; (2) that the kind of feed is not a cause of cows producing low solids-not-fat milk; (3) that the solids-not-fat content of the milk varies from year to year; (4) that the ratio between fat and solids-not-fat varies from year to year; (5) that inheritance is an important factor in determining the composition of the milk given by a herd; and (6) that cows affected with mastitis produce on an average milk lower in solids-not-fat than cows free from mastitis. *(Purnell Fund)*

Dry-Feed Systems of Raising Dairy Calves

During the past year eight calves from the university herd have completed their six months' feeding period on experimental rations.

Data reported heretofore have dealt with the diet wherein skim milk plus concentrated cod-liver oil has been substituted for whole milk feeding at an early age. Under the conditions of feeding at the university, this ration has afforded extremely satisfactory growth and has produced calves apparently normal in every way. Much interest has been shown in the use of concentrated cod-liver oil with skim milk, but more information has been requested regarding the use of re-constituted skim milk since ordinary fluid skim milk is not available on the average New Hampshire dairy farm, reports K. S. Morrow.

In the winter of 1938-39 four calves were selected for this particular trial. Two were fed the reconstituted skim milk ration and two were fed the regular skim milk ration. Concentrated cod-liver oil was added to both rations. The calves were left with their dams twelve hours following parturition. The dams' milk was fed on the average of four days and then the calves were placed on the experimental diet, the milk being fed at a level approximating 10 per cent of the live weight, with a maximum of 16 pounds daily. The experimental period covered the first 180 days of age.

The animals on the reconstituted skim milk ration did not make as good growth, measured by either body weight or height at withers as did the two heifers on the regular skim milk. Until two months of age, digestive disturbances were noticeable in the heifers on the reconstituted milk. On several occasions scours were evident, and during the entire feeding period, the feces appeared very sticky. These animals could not be put on maximum milk feeding as early as the other two. More data are necessary for definite conclusions, but the indications from the feeding of these two animals on reconstituted milk are that the ration was not as conducive to normal growth and general well-being as a ration in which natural skim milk was used.

During the past summer a trial was conducted with four Guernsey calves on limited whole milk feeding. This experiment was designed to test the feasibility of weaning calves from whole milk at six to eight weeks of age and depending upon a dry ration of grain and hay thereafter until six months of age. This type of ration would be practical on many New Hampshire farms where whole milk is limited and where the feeding of a fluid milk of any sort is discontinued early. In a trial, skim milk powder was added to the regular university calf ration to the extent of 25 per cent, making the following mixture: 400 lbs. ground yellow corn, 300 lbs. wheat bran, 200 lbs. ground oats, 100 lbs. cottonseed meal, 100 lbs. linseed oil meal, 365 lbs. skim milk powder, 12 lbs. salt, 12 lbs. steamed bone meal, .25 per cent (3.7 lbs.) cod-liver oil concentrate. Calves started on this grain at as early an age as the appetite permitted and were fed up to a maximum of 5 pounds daily. Whole milk was fed at the rate of about 10 per cent of the live weight. In this trial the concentrated oil was added to the whole milk.

The average rate of growth for these calves was above normal although they were weaned at 44 days of age. Most experiments of this type have weaned the animals at 8 or 9 weeks. The trials indi-

cate that whole milk feeding can be discontinued at between 7 and 8 weeks of age and that skim milk can be fed dry as an ingredient of the grain ration so as to accomplish normal growth and health.

Following a survey of calf-feeding methods on New Hampshire farms, twenty-five to thirty dairymen will submit detailed monthly reports on a calf-feeding study in which feed and growth records are tabulated and checked by the D.H.I.A. tester. In addition to this study, a program is to be launched by the county agricultural agents in cooperation with the farm management and dairy departments whereby limited data on growth and feed records are to be secured from 700 to 750 dairy herds in New Hampshire. These data should include upwards of 1,500 animals and prove of much value in determining farm practices in the raising of dairy replacements.

(Bankhead-Jones Fund)

Efficiency of Dairy Herd Management Practices as Revealed by Analyses of Permanent Records of D. H. I. A. Herds in New Hampshire

Work on this project to date has consisted principally of tabulating data from D.H.I.A. records to use in the analyses. All production records must be converted to a common mature equivalent basis and feed tabulations made for both the milking and the dry periods. In addition, breeding history is recorded so that inheritance studies can be made. To date information of this type is available for 40 herds numbering approximately 2,500 cows. It is felt that data on 5,000 cows should be tabulated before detailed analyses are made, in order to have significant numbers to overcome individual and environment factors. *(Purnell Fund)*

The Relation of the Conformation of the Dairy Cow to Her Milk and Butterfat Production

Ante-mortem and post-mortem data were secured from three animals during the past year, making a total of thirteen animals studied to date under this project. The information was tabulated and forwarded to Washington for inclusion with similar data from other stations cooperating on this project, reports K. S. Morrow.

No attempt has been made to analyze individual differences in the data although interesting anatomical variations are observed as the data accumulates. *(Bankhead-Jones Offset Fund)*

The Normal Growth of Dairy Heifers

All dairy calves born in the university dairy herd are weighed at weekly intervals until six months of age and at monthly intervals from that age until twelve months. (Some of these animals may be on experimental diets and are reported elsewhere.) Studies of these data will indicate normal growth for animals as handled under the methods used with the university herd and will serve as standards against which comparisons of experimental rations can be made. K. S. Morrow is in charge of the work.

(Miscellaneous Income)

Engineering

Control of Moisture in Poultry Litter

(See under Poultry Husbandry)

Potato Storage Structures

Studies were begun in the summer of 1939 by W. T. Ackerman to determine the structural requirements and engineering problems involved in the construction and equipment for heating, ventilating and humidity control of individual potato storages for average size farm use. Five storages in actual operation on farms in the state were selected. These ranged in type of construction from the very lowest cost attainable, through the average masonry basement with wood super-structure, to the high cost monolithic concrete and steel construction.

The first year's investigations are planned to eliminate known causes of heat loss or cold entrance in so far as possible with continuous temperature and humidity readings for the quality of operation, so that further improvement of structural and engineering factors may be made in the summer of 1940. The cost of construction and structural details as planned will also be obtained and analyzed.

(Purnell and Bankhead-Jones Offset Funds)

Testing and Advisory Service

Examinations, tests and advisory services on new equipment for agricultural and rural use, especially in the electrical field, served to protect both merchandiser and consumer from costly mistakes in experimenting with new devices, report W. T. Ackerman and G. M. Foulkrod. New types of tractors, a traction dynamometer, home-built electric brooders, water-supply pumps (compressed air jet and turbine types), new style flood lights, ultra-violet lamps for poultry, and motor-driven grindstones were under investigation this year.

(Bankhead-Jones Offset Fund)

Electric Washing and Sterilizing Equipment for Dairy Utensils

Studies of electrical washing and sterilizing equipment were limited to preliminary work on three devices,—a combination dairy water heating-washing-sterilizing unit, a dairy sterilizing cabinet, and an electric dairy water heating pail, reports W. T. Ackerman.

(Bankhead-Jones Offset Fund)

Entomology

The Penetration of Contact Insecticides

This fundamental investigation has proceeded with a study of further materials, in addition to those noted in the previous report. A fairly large body of data has now been accumulated on two petroleum derivatives, steam-distilled pine oil, and six alcohols, from methyl to octyl. Among these various liquids maximum penetration of insect integument was exhibited by a low-boiling petroleum derivative (5 to 7 carbons) standardized under the name "Apcothin-

ner." Another petroleum derivative (a standard, purified household spray kerosene) gave much lower penetration, approximately only one-sixth as much as the lower boiling fraction.

Among the alcohols maximum penetration was exhibited by methyl. Normal propyl, iso propyl, and butyl, showed closely parallel rates of penetration, all three being much inferior to methyl, which gave four times as great a penetration rate. Ethyl and octyl alcohols gave somewhat higher amount of penetration than the three just named, but much less than methyl.

Pine oil gave somewhat lower penetration than the alcohols.

Considerable work was done with acetone, mesityl oxide and butyl ether, but each of these requires much additional investigation before results can be considered reliable. Acetone could not be confined with any of the cements so far available. Mesityl oxide and butyl ether could be held for a fair observation period, but showed leakage at the end of the complete period of study.

The work already done with the petroleum derivatives was repeated, in order to verify data already secured. Results of the second investigation agreed substantially with previous results.

The technique employed in these studies was subjected to a rather elaborate investigation to affirm its validity. The results of this were satisfactory. Also, extensive work was done in calibration of apparatus.

Results of that part of the investigation which are reasonably complete have been prepared for publication as a research bulletin in the contact insecticide series. The work is conducted by W. C. O'Kane, J. G. Conklin, L. C. Glover and R. L. Bickle. *(Purnell Fund)*

The Penetration of Ovicides

This investigation was planned by W. C. O'Kane, R. L. Blickle and L. C. Glover to shed light on the amount and rate of penetration of various liquids into an insect egg. The liquids studied include mineral oils of several viscosities and several degrees of saturation, a number of glycerides, and some turpenes. The liquid under study is saturated with a dye, the insect eggs are placed in it for a constant period, and the egg is then sectioned, using a freezing microtome. The investigation has afforded the following information:

Mineral oils of low viscosity penetrated the egg more quickly than oils of higher viscosity.

Mineral oils low in unsaturates penetrated more quickly than the corresponding oils containing a larger percentage of unsaturates.

Mineral oils gave more rapid penetration than glycerides of approximately the same viscosity.

Steam-distilled pine oil penetrated more rapidly than glycerides, and more rapidly than mineral oils, except those of very low viscosity.

Among the insect eggs used those of the American roach showed most rapid penetration, followed by the eggs of the Colorado potato beetle, and then by those of the Mexican bean beetle.

Preliminary studies on the relationship of the age of an insect egg to speed of penetration (using eggs of the Mexican bean beetle) in-

dicated that with this species the older eggs were more rapidly penetrated than the younger eggs. *(Adams Fund)*

Insect Records During the Year

The European corn borer was much more abundant in New Hampshire in 1939 than for several years past, reports W. C. O'Kane. Commercial damage occurred in a number of areas in the southern half of the state. Positive evidence of the occurrence of the two-generation strain in the northern part of the state (Conway area) was obtained. The department cooperated with the Federal bureau in making a fall infestation survey of the European corn borer in Carroll, Merrimack, Belknap, Strafford, and Rockingham counties.

The gypsy moth was noticeably more abundant this year than for several years past, and the department was called upon to investigate outbreaks in many parts of the state.

Additional observations have been made of the distribution and abundance of the European spruce saw-fly in New Hampshire. Over 1,300,000 *Microplectron* were reared this season and liberated in the areas where the saw-fly is known to be present. Ecological studies have been continued in the Dublin area. These studies are intended to yield information on the effect of predators on the hibernating stages of the saw-fly. The experimental plots originally established on Mt. Monadnock were rendered useless as a result of the hurricane of 1938, and new plots have been established on Beech Hill, in the town of Dublin. This work is in cooperation with the Federal bureau. *(Hatch Fund)*

Forestry

White Pine Stands

K. W. Woodward supervised the work of thinning and mapping reproduction plots of various ages. Data were obtained regarding the rate of growth of stand, the yield that may be expected at different ages, the utilization of small materials derived from thinning, and the flora and fauna present throughout the life of the stand. *(Hatch Fund)*

Plantation Studies

Each plantation was mapped, measured, and examined. The information collected on the rate of growth of planted Scotch pine, Norway spruce, white spruce, white pine, etc., will be analyzed. Plantations set in 1938 showed a 90 per cent survival in the spring of 1939, but it is doubtful whether results will be as satisfactory when the 1939 plantations are measured next year. *(Hatch Fund)*

Sustained Yield Study in Northern New Hampshire

The survey was completed July 1, 1939. The area of woodland covered showed a total of 100,343 acres in Vermont and 188,411 acres in New Hampshire. Timber volume was measured in Coos county, N. H.: all species, 1,129,833 cords; in terms of board feet, 264,541,240; fence posts, cedar 1,858,035, tamarack 947,247; guard posts, cedar 588,728, tamarack 336,424; poles, cedar 91,021, tamarack 33,048.

Annual growth in Coos county was estimated at 44,753 cords. This survey applies to small holdings in the towns in the Connecticut valley and parts of some towns in the Androscoggin valley.

(Purnell Fund)

Home Economics

An investigation of textile fabrics from the retail consumer's point of view is being conducted in cooperation with other northeastern experiment stations. Project leaders and their associates in each of the states collect swatches of fabrics of specified size from consumers who are making them into women's or children's garments, and at the same time obtain information relating to the purchase of the fabrics. These are sent to the textile chemistry laboratory at the Pennsylvania State college, which serves as the testing laboratory for the project.

In this state 67 samples have been collected for analysis. Reports of these tests have now been returned and have been placed in the hands of the women who furnished the material. The second step in this cooperative project is that the garments, when they have passed their days of usefulness, are to be sent to the laboratory for further study of the wearability. *(Purnell Fund)*

Horticulture

Apple Fertilizers

In three orchards which have been treated with potassium nitrate in contrast to sodium nitrate as a source of nitrogen in order to determine whether "arrow-head" scorch on the leaves was due to potash deficiency, A. F. Yeager found that the condition was worse on potash-treated trees. Evidently the scorch is due to some other factor which required investigation. The report of the New Hampshire Horticultural society gives the data under the title "Orchard Experiments."

A study of the records of bearing apple trees grown at the university and in orchards over New Hampshire which were available, indicates that tree girth is a fair index of the productiviy of a tree during the following two years but may be worth very little as an indicator of what it will do in either of these years alone. The average of two successive years' yield records is a good indicator of the probable yield of the tree in future years. It is much better than girth alone. This information is important in that it provides a basis for the selection of trees to be used in experiments. The reliability of experiments is often questioned because of the inherent variability of the trees used. If we can thus eliminate as much of this variability as seems possible, then we may be more certain that the results of any fertilizer test or other experiment are accurate. A paper on this subject will appear in the 1939 report of the American Society for Horticultural Science under the title "Tree Girth and Yield as Indication of Subsequent Apple Tree Productivity" by A. F. Yeager and L. P. Latimer. *(Purnell Fund)*

Apple Spraying

A considerable number of mild sulphurs were used in comparison with each other and with lime sulphur as a means of controlling scab. Where these mild sulphurs were of sufficient fineness and purity, they gave nearly as good control as did lime sulphur, and the yield from the trees sprayed with mild sulphurs was larger than that from those sprayed with lime sulphur solution. Where one or two sprays of lime sulphur were substituted for the mild sulphur, when it appeared there might be excessive damage due to scab, the lime sulphur did reduce the scab infection. The detailed data is given by A. F. Yeager in the New Hampshire Horticultural society report for 1939. *(Hatch Fund)*

Strawberry Studies

Howard 17 plants from a Delaware nursery, a New Hampshire nursery and the University of New Hampshire were used to compare the effect of plant source on the productivity of this variety, reports L. P. Latimer. The commercial plants from outside sources both showed "gold leaf" in varying amounts averaging 15 per cent. The New Hampshire university plants showed none since particular care had been taken to eliminate this disease by selection in past years. The Delaware plants were less vigorous. The yields in 1939 showed no significant differences attributable to "gold leaf," but the smaller production of runners by the Delaware plants did reduce their crop in proportion.

Borax application as low as five pounds per acre caused a trace of leaf scorch on strawberries. This was light up to 20 lbs., became markedly heavier at 40 lbs., and at 80 lbs. was quite severe. The yield was not reduced except by the 80 lb. application. The injury was evident as brown spots in the center of the leaves and brown leaf margins, but no bleaching of mid-ribs was evident.

A variety test of strawberries showed their productivity beginning with the highest, to rank in the following order: Cato, Howard 17, Culver, Catskill, Dorsett, and Fairfax, with 7 others ranging downward to Jupiter with one-sixth the yield of Cato. *(Hatch Fund)*

Apple Drop

Boron-sprayed trees dropped their fruit less than the unsprayed, reports L. P. Latimer. The apples from the treated trees were no larger and had no more seeds than from the untreated but were significantly better colored. The yield was not increased. Boron did not increase the firmness of the fruit as indicated by a pressure test. Cork spot was satisfactorily controlled by boron either as a spray or as a fertilizer. *(Purnell Fund)*

Blueberry Improvement and Propagation

Cuttings which were dipped in Semesan before planting showed little evidence of damping off and it was found that the treated cuttings rooted much better than those which were untreated, even though the untreated ones did produce some roots. A comparison

of basal and terminal cuttings showed no difference in the per cent rooted but the basal ones made more growth as did also heavy cuttings as compared to light ones taken from the same portions of the plants. Hormones gave no beneficial results in rooting. Transparent cellulose film gave good results as a frame cover, but it was found that the frame requires sloping so that the water will run off, otherwise the wet film stretches. Used burlap as a shade for propagating frames, proved insufficient to prevent burning. Hence it was found necessary to add an extra layer of burlap. A variety test was planted with the rows running through soil of varying moisture content. Wild blueberries were successfully transplanted to this field for observation.

There is increasing evidence that blueberries do better on light, sandy soil than where there is some clay, reports W. W. Smith. Early freezing of the tips may be the cause of much of the injury attributed in the past to exposure to low temperatures above the snow line in the late winter.

Seed germination studies with the low bush blueberry were started to determine the practicability of field seeding. Gypsy moth was a serious problem. *(Hatch Fund)*

Rootstock Project

The propagation of stock for later study occupied most of the time in this project, reports W. W. Smith. Buds set in August, 1938 made a satisfactory growth. A considerable amount of ring grafting was done by placing a ring of bark of a stock such as Malling No. 9 on Virginia Crab seedlings. This was done to determine interstock effects. Notes were taken on a planting at Gilford where various Malling stocks were used. These trees are not yet in bearing. There was a noticeable looseness of trees on the very dwarfing stock Malling No. 4. *(Bankhead-Jones Fund)*

Winter Injury

Late fall nitrogen applications are conducive to winter injury. Some trees lose all of their bark and on others frost rings are evident. These are more frequently found on the north side of the tree than on the south. A paper on this subject is being published in the 1939 report of the American Society for Horticultural Science under the title "Frost Rings in Fall Fertilized McIntosh Apple Trees" by W. W. Smith and M. A. Tingley. *(Adams Fund)*

Vegetable Project

Seed stocks of the New Hampshire Hybrid eggplant are being maintained. This variety has made an excellent record in eastern United States. Continued inbred selections are being made.

From a cross between the Gage bean, a shell variety with much color on the seed but no pod color, and French Horticultural, a variety having highly colored pods with light colored seed, the F^1 and F^2 generations have been produced. It is evidently possible to combine the high color of the Gage seed with the high color of the French Horticultural pod. This was the object of the cross. A large

number of selections of this type have been made with the object of securing the best possible quality in other respects combined with the two points already mentioned.

The F^1 of a cross between Pinkie, a high popping quality pop corn, and White Pearl, an adapted New England white pop corn, was made in 1938. The F^1 was produced in 1939. A range in seed color from practically black through various degrees of red and pink to white is to be noted on these ears.

The variety test of watermelons again demonstrated that some of the new varieties from Japan, particularly Sweet Japanese and Early Sugar, are well adapted to New Hampshire conditions. Some seed was produced for distribution in small amounts. Waltham Beauty was the outstanding early commercial pepper variety this year, although Italian Sweet appeared promising for home gardens. Angular leaf spot practically ruined the muskmelon variety tests. It is evident that new varieties are needed.

About 120 varieties and strains of sweet corn were grown. Of these Cockscrow, Conn. 6.4x13, and Spancross C4x13 were the best earlies, Burpeecross, Early Bancross, Spancross 39-4 and Conn. P39-10 x C13 the best medium, and Golden Cross Bantam, Maine Tricross, Maine Topcross and Maine 1.37 the best late varieties.

In a cooperative experiment with the entomology department it was found that corn planted May 15 and July 1 was much worse infested by Mexican bean beetle than corn planted around June 1. A dusting experiment on squash for the control of cucumber beetle using four different materials gave inconclusive results. None were entirely satisfactory. In a fertilizer trial with squash it was found that the use of readily available nitrogen in the hill such as tankage alone, and manure and commercial fertilizer together, increased the yield considerably.

A popping test with 55 varieties of pop corn raised in 1938 showed a great variation in the amount of expansion ranging from 4.7 with Golden Tom Thumb up to 22.4 for a local strain of White Pearl. The yields, length of season required, and the quality were also recorded for all of these varieties in order that we might better be able to advise growers in New Hampshire on these points.

This work was in charge of J. R. Hepler. *(Hatch Fund)*

Ornamentals

Two hundred seventy-two named varieties of Iris are in the trial garden, reports H. S. Clapp. This is in cooperation with the American Iris society.

One hundred thirty-two new shrub varieties were received from the Arnold Arboretum to be used as a nucleus for an adaptability trial of such materials. *(Hatch Fund)*

Poultry

Protein Requirements of Chickens

Previous studies of various protein levels with milk, meat and fish as the animal protein constituents have been carried on by R. C. Durgin, T. B. Charles and A. E. Tepper with birds in batteries and

laying cages. Previous results have been summarized and published in Bulletin 312. For the year 1939-40 similar studies are being carried on with birds held in floor pens. These studies will record the effect of various animal protein sources at different levels upon fertility and hatchability, as well as mortality, growth efficiency, and egg production.

The chemical phases of this project have been expanded and considerable data obtained by S. R. Shimer and H. A. Davis. Portions of the analytical work and a comprehensive study of the data are still in progress.

In searching for a suitable method to determine the uric acid in the mixed excreta of the birds, several methods were investigated. Two methods in particular were tried and that of Shirley and Van Landingham was found to be the most satisfactory. Further studies, however, will be made with both methods.

The samples collected from the feeding experiments mentioned in the last annual report have been analyzed. A second feeding trial was made with the only difference being that the feed was in the form of pellets rather than dry mash.

At the conclusion of the feeding experiment, the alimentary tract of each bird was removed and the pH of the various portions of the tract, together with its contents, was determined. This work is being continued. *(Purnell Fund)*

Re-test of Gas-Burning Brooders

To test further the efficiency of gas-burning brooders, another test was made by T. B. Charles and P. A. Wilcox during the spring of 1939 at the University Poultry farm.

The company manufacturing the brooder under test, as a result of our previous year's recommendation, equipped it with a larger gas-burning head, which was the only change made.

The brooding period extended from February 16, 1939 to June 10, 1939. The breed used was Barred Plymouth Rock. Mortality to twelve weeks was only 3.2 per cent from all causes. One chick was picked, and one accidentally hanged.

Growth, feathering and general condition of chicks were satisfactory. The cockerels' average weight was 2.97 pounds at 12 weeks of age, and the pullets' 2.6 pounds each at 12 weeks of age.

The results secured with the gas-burning brooder, which had been provided with a special burner for cold weather use, indicated that this method of brooding can be successfully used during cold weather. The gas consumed was 310 lbs. during the twelve-week brooding period. *(Purnell Fund)*

Record of Performance

With an increase this coming year, (1939-1940), in Record of Performance membership, fourteen members will enter approximately 5,500 pullets and 1,300 turkeys under the program as compared to eleven members having entered 4,637 birds during 1938-39, report R. C. Durgin and David Flagg. Of these 4,637 birds, 1410 or 30.4 per cent met Record of Performance requirements. To meet Record of

Performance requirements, birds must lay a minimum of 200 standard-sized eggs in a laying year. *(Miscellaneous Income)*

Poultry Approval

During the year 1938-39 New Hampshire poultrymen had 20,500 birds handled and selected by R. C. Durgin, selecting agent. This process of selection and culling is called "approval." Both Poultry Approval and New Hampshire Record of Performance regulations comply with the provisions of the National Poultry Improvement program. *(Miscellaneous Income)*

Selective Breeding as a Control of Ruptured Egg Yolk

This project which was carried on by R. C. Durgin, C. L. Martin, M. S. Cover, A. E. Tepper, T. B. Charles and C. A. Bottorff endeavored to develop both susceptible and resistant lines to the condition known as ruptured egg yolk. Post-mortem records maintained by this department indicate this condition to be one of the major causes of adult mortality.

During the spring of 1939, one hundred ninety-eight chicks were pedigree-hatched from families which showed a low incidence of this condition. Two hundred twelve chickens were hatched from families which showed a high incidence of ruptured egg yolk. From these chicks we have housed five families of 63 birds from the low mortality mating and five families of 58 birds from the high mortality group. From this beginning it is hoped that we may be able to develop two distinct lines, one showing a high and the other a low incidence to ruptured egg yolk condition. *(Purnell Fund)*

Controlling Moisture in Poultry Litter

The principal reason for work on this project has been the problem encountered by poultrymen generally of wet litter in pens of laying hens. Various efforts have been made to control this situation through insulation, ventilation, change in type of litter, and other measures without a satisfactory solution having as yet been found, report T. B. Charles, W. T. Ackerman, R. C. Durgin, G. M. Foulkrod, A. E. Tepper and B. J. French. The first year's operation involved the recording of temperature, humidity, litter moisture, and air movement conditions as existing in pens of various types of construction. Pen temperatures in unheated houses from the last of November to the first of May (the period when this problem is most acute) were an average of 8.3 degrees higher than the outside air. In the coldest period, a differential of 13 degrees was reached, while in the warmer spring conditions this was reduced to 5 degrees. These factors are of value in considering the effectiveness of natural draft ventilation.

Humidity records showed an average of 59 per cent moisture in outside air for the five months' period, with monthly average maximums as high as 63 per cent. The pen average for the five months was 81 per cent, with average monthly maximums of 84 per cent.

The measure of moisture in pen litter and similar litter without hens showed that for the five months' period an average of 45.3 per

cent moisture developed in pen litter and only 10.9 per cent in litter without hens. Various kinds of litter showed an average range in moisture accumulation of 6.6 per cent when exposed to air conditions without hens.

The establishing of data such as the above will be followed by an investigation of the source and means of entrance and removal of this excess moisture. No significant differences in feed consumption, egg production, or mortality were observed.

(Purnell and Bankhead-Jones Offset Funds)

A Study of Paralysis in Chickens

During the past year a family of White Leghorn adult birds was obtained which had been showing much evidence of fowl paralysis. This family consisted of one male and three female birds. These birds were mated in a battery. Eggs were saved in an attempt to obtain progeny from this family. The birds produced well for a short time but later failed to produce at all. One bird died during the experiment and showed the presence of the paralysis. The left sciatic nerve was greatly enlarged indicating fowl paralysis of the neurolymphomatosis type.

The eggs obtained failed to hatch and since the birds ceased to produce the experiment was terminated. The work was in charge of C. L. Martin and M. S. Cover. *(Purnell Fund)*

The Control of Coccidiosis in Poultry

As a result of attempts to inoculate birds with coccidiosis, it is concluded, by C. L. Martin, M. S. Cover, T. B. Charles and R. C. Durgin, that if birds under our climatic conditions can be housed in the late fall free from chronic coccidiosis, the chance of their becoming infected before warm weather or late spring and summer is remote. *(Purnell Fund)*

Bang's Disease

This project has been completed and will be reported upon early in 1940. *(Purnell Fund)*

The So-Called Trembling Chick Disease

No work has been done on this project during the past year. In 1939-40 the study will be directed towards determining the natural method of transmission of this disease. Its causative agent has been shown to be a virus. *(Purnell Fund)*

Ulcerated Gizzard and Vitamin C Studies

The first cases of ulcerated gizzard in chicks were noted in the spring of 1935. Since that time there has been a steady increase in the number of chicks autopsied for this complaint.

Consideration of the possible causes of this disease leads to the study of poultry rations. Vitamin C, according to various investigators, is essential for proper metabolism, proper mucous membrane, and connective tissue development. An interference in the develop-

ment of these could very well result in an improperly formed gizzard lining.

Four feeding experiments were made in which fresh lemon juice, atropin sulfate, arecoline hydrobromide, weak base and acid solutions, and cevitamic acid were included in the ration. In one of these experiments, chicks were fed on a ration lacking in Vitamin C.

The results of these experiments were somewhat contradictory and, until further work can be done on this problem, no conclusions can be drawn. This project is in charge of M. S. Cover and C. L. Martin. *(Miscellaneous Income)*

Methods of Administering Medicine to Sheep

To secure maximum efficiency in administering liquid medicants, sheep should be fasted for at least twenty-four hours previous to the treatment, reports C. L. Martin. When this is done and the medicine is administered to sheep in an upright position, liquid medicine will follow the esophogeal groove through the rumen and reticulum to the omasum and abomasum, its desired destination, more often than if the sheep are not totally fasted.

Capsules as a means of giving medicine for stomach worms are a waste of time and money. They go only to the rumen, dissolve their shell, and empty their contents into the rumen ingesta. By the time this reaches the abomasum, the medicant has lost the major part of its effectiveness.

This work will be checked further as sheep are obtained.

Pullorum Eradication in New Hampshire

A new record for testing the largest per cent of adult birds in any state in the Union was established during the season 1938-39 under the supervision of the New Hampshire Department of Agriculture, Division of Animal Industries. Of the total adult birds, 52.5 per cent were tested with 99.8 per cent not reactive. There were 716,496 blood samples tested for pullorum from 546 flocks, having 683,128 chickens, 2,286 turkeys, 40 geese, and 5 ducks, as compared to 549,064 blood samples tested from 442 flocks the previous season. Fifteen new flocks were added to the pullorum-clean list, and 5 were removed for failure to test, bringing the total to 106.

The large amount of testing was due to financial assistance given by the Department of Agriculture toward the eradication of pullorum from New Hampshire poultry flocks. *(Miscellaneous Income)*

Poultry Autopsies

A total of 2,678 autopsies were made during the fiscal year of 1938-1939 by C. A. Bottorff, C. L. Martin and M. S. Cover. This number involved 731 cases for state poultrymen. For the state work there were 259 chick cases including 1,269 chicks; 434 adult cases, including 901 birds; 38 turkey cases involving 68 turkeys and also 3 pigeons, one song sparrow, one partridge and one swan.

The leading disease of adults this year was contagious indigestion (blue comb); 23 per cent of all cases showed the presence of this disease. Ruptured egg yolk was second in importance showing up in

13 per cent of all adult cases. Chronic coccidiosis and fowl pox were third and fourth in order as stated. The disease known as blue comb has within the past three years jumped from the unknown into a position of leading importance. Ruptured egg yolk has been in previous years the most important adult trouble but this year it is definitely over-shadowed by blue comb. The incidence of fowl pox was very high because of the epidemic which was present here in the Northeast during the fall and winter of 1938-39. The principal diseases of chicks were as follows: ulcerated gizzards, 57 cases or 21 per cent; chronic coccidiosis, 42 cases or 15 per cent; tremors, 34 cases or 13 per cent; pullorum, 26 cases or 10 per cent. Ulcerated gizzard this year again has taken the place as the leading chick disease. *(Miscellaneous Income)*

FINANCIAL STATEMENT

Expenditures of the New Hampshire Agricultural Experiment Station
for the Year Ending June 30, 1939

	FEDERAL FUNDS				Bankhead Jones Offset	Supplementary*	Total
	Hatch Fund	Adams Fund	Purnell Fund	Bankhead Jones			
Personal services	$9,378.55	$13,228.57	$51,909.71	$5,743.04	$6,123.52	$27,237.85	$113,621.24
Supplies and materials	460.11	288.41	2,397.55	271.77	393.78	4,816.99	8,628.61
Communication service	734.20		33.68	15.08	24.22	321.29	1,128.47
Travel expenses	525.46	60.45	2,290.27	620.12	162.13	1,422.95	5,081.38
Transportation of things	311.03	11.82	73.19	1.73	18.58	78.22	494.57
Publications	316.65		1,055.30	2.35			1,374.30
Heat, light, water, and power	700.00		34.02			138.41	872.43
Contingent expenses	31.53		15.11			102.99	149.63
Equipment	2,542.47	1,241.72	1,764.65	70.88	590.32	2,386.46	8,596.50
Buildings and land		169.03	426.52	587.58		34.64	1,217.77
Balance						22,288.37	22,288.37
Totals	$15,000.00	$15,000.00	$60,000.00	$7,312.55	$7,312.55	$58,828.17	$163,453.27

*This fund includes expenditures from the following sources:

State appropriations	$ 7,312.55
Sales and miscellaneous income	51,515.62
	$58,828.17

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